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Engineering Design File

INEEL CERCLA Disposal Facility Test Pad Construction Report

Prepared for:
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Idaho Operations Office
Idaho Falls, Idaho

Idaho National Engineering and Environmental Laboratory

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1. Title: INEEL CERCLA Disposal Facility Test Pad Construction Report

2. Project File No.:

3. Site Area and Building No.:

4. SSC Identification/Equipment Tag No.:

5. Summary:

This report summarizes the construction quality assurance (CQA) activities and documentation during the construction of test pad at the INEEL CERCLA Disposal Facility (ICDF) at the Idaho National Engineering and Environmental Laboratory (INEEL) near Idaho Falls, Idaho.

The purpose of the test pad construction is to determine the acceptable processing, placement, and compaction methods to be used for the Phase II construction and to verify the laboratory performance of the low permeability compacted clay admix soil liner of the ICDF landfill. A study was performed to determine bentonite amendments required to the designated clay base soil to achieve a maximum in situ saturated hydraulic conductivity of 1×10^{-7} cm/sec. Additionally, the test pad construction will verify the moisture content and density required to achieve the desired hydraulic conductivity and to determine the acceptable processing, placement, and compaction method.

6. Review (R) and Approval (A) and Acceptance (Ac) Signatures:
(See instructions for definitions of terms and significance of signatures.)

	R/A	Typed Name/Organization	Signature	Date
Performer		Bryan Fritzler/Vector Engineering	[illegible] for Bryan Fritzler	5-9-02
Checker	R	(same as Independent Peer Reviewer)		
Independent Peer Reviewer	A	Marty Doornbos, ORB Chair/ 6710	Marty Doornbos	5/9/02
Approver	A	Tom Borschel/6790	Tom F. Borschel	5-9-02
Requestor	Ac	Don Vernon/6250	D. Vernon	5/9/02

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FIGURES

TABLES

ACRONYMS

BBWI	Bechtel BWXT Idaho LLC
CL	lean clay
CQA	construction quality assurance
DOE-ID	U.S. Department of Energy Idaho Operations Office
EDF	Engineering Design File
ICDF	INEEL CERCLA Disposal Facility
INEEL	Idaho National Engineering and Environmental Laboratory
QC	quality control
RGF	Rye Grass Flats

INEEL CERCLA Disposal Facility Test Pad Construction Report

1. INTRODUCTION

This report summarizes the construction quality assurance (CQA) activities and documentation during the construction of test pad at the INEEL CERCLA Disposal Facility (ICDF) at the Idaho National Engineering and Environmental Laboratory (INEEL) near Idaho Falls, Idaho.

The purpose of the test pad construction is to determine the acceptable processing, placement, and compaction methods to be used for the Phase II construction and to verify the laboratory performance of the low permeability compacted clay admix soil liner of the ICDF landfill. A study was performed to determine bentonite amendments required to the designated clay base soil to achieve a maximum in situ saturated hydraulic conductivity of 1×10^{-7} cm/sec. Additionally, the test pad construction will verify the moisture content and density required to achieve the desired hydraulic conductivity and to determine the acceptable processing, placement, and compaction method. The purpose of CQA monitoring during the test pad construction is to verify that proper construction techniques and procedures were used and to confirm that the test pad was constructed in accordance with the project plans and specifications. The controlling documents for this project were as follows:

1. "INEEL CERCLA Disposal Facility Final Design Excavation and Test Pad –Master Table of Documents" (DOE-ID 2001a)

2. "INEEL CERCLA Disposal Facility Construction Quality Assurance Plan for Excavation and Constructing and Testing Clay Liner and Test Pad" (DOE-ID 2001b)

3. "INEEL CERCLA Disposal Facility Specifications for Excavation and Constructing and Testing of Clay Liner and Test Pad," (SPC-1475)

4. "Soil Amendment Study," (EDF-ER-272).

The ICDF design and construction subcontractor was CH2M Hill Constructors, Inc., under the direction of Mr. Brian Corb, Construction Manager, and Mr. Craig Reese, Construction Supervisor. The CQA Certifying Officer – Independent Third Party, was Mr. Bryan Fritzler, P.E., of Vector Engineering, Inc. During the test pad construction, the CQA Monitor – Independent Third Party, was Mr. Erik Olhoffer of Vector Engineering, Inc., who was assisted by INEEL's technicians.

The test pad construction consisted of

- Borrow excavation

- Material processing, including clod reduction, moisture content adjustment, and bentonite mixing

- Test pad subgrade preparation

- Clay liner construction.

Off-Site laboratory conformance testing for the clay permeability was performed at Vector's laboratory in Grass Valley, California, under the direction of Mr. Bryan Fritzler, P.E., and Mr. Ken Criley, laboratory manager.

The following report contains a discussion of the CQA procedures performed, a discussion of the construction activities, results of the tests, and conclusions and recommendations. This report also contains appendices describing the daily construction activities, field and laboratory testing results, and other information pertaining to the quality assurance monitoring of the test pad construction.

2. TEST PAD CONSTRUCTION SUMMARY

2.1 General

Construction components of the test pad consisted of materials preparation, bentonite mixing, subgrade preparation, clay liner material placement and compaction, and surveying.

All the tasks described above, except surveying, were conducted by CH2M Hill personnel or their subcontractors. Direct supervision of the construction crews was provided by Mr. Brian Corb and Mr. Craig Reese of CH2M Hill. Construction Quality Control was provided by Mr. Brodie Adams of Montgomery-Watson. The two test pads constructed, referred to as Lane A (815 CAT) and Lane B (825 CAT), have an approximate dimension of 50 ft wide, 90 ft long, and 3.5 ft thick. The construction was initiated August 2, 2001, and was completed by October 8, 2001. Final survey was conducted by BBWI.

2.2 Construction Method

2.2.1 Material Preparation

The material to construct the test pad was obtained from the borrow excavation area known as Rye Grass Flats (RGF). The RGF materials were excavated by utilizing a CAT 966 loader and placed in 10-wheel end dump trucks and semi-trailer trucks and transported to the stockpile area. Moisture conditioning was performed on the stockpile area by adding water through a water truck side sprayer and mixing by utilizing CAT 330B excavator. The quality control (QC) personnel then retrieved samples for moisture content testing.

2.2.2 Mixing

Upon completion of moisture conditioning, the materials were then transported to the mixing pad by utilizing a CAT 966 loader. Prior to mixing, several loads of the stockpiled material, referred to as RGF Sacrificial, were placed directly on the ground in order to construct a base foundation for the mixing and processing. The foundation layer was then sprayed with water and wheel-rolled with a CAT 966 loader. The final surface was graded with a CAT 143H motor grader.

The RGF materials were then placed on the mixing pad and spread in 7-8 in. loose lifts. Clod reduction to a maximum of size of 0.5 in. was performed by rotovating the materials using a pull-behind rototiller. Upon completion of clod reduction, the soil mass was determined by measuring the depth of the rotovated materials using metal T-probe. The density was determined by sampling the soil using shelby tubes and then calculating the weight and volume. Based on the soil mass and the moisture content measured previously, the amount of bentonite required, 5% based on dry weight, was determined.

The defined amount of bentonite was then spread evenly over the mixing pad by utilizing a pull-behind spreader. During the placement of the bentonite, the quantity of bentonite was verified by measuring (weight) the bentonite collected in a large pan with a know area. Based on the visual observation of the bentonite spreading and the varying weights from the pan measurements, it was determined that in many instances the spreader was not able to distribute the bentonite evenly over the mixing area; therefore, in some instances the bentonite was then distributed more evenly over the mixing pad manually. Since the verification of the bentonite quantity by the pan measuring method was not adequate due to the uneven distribution of the bentonite, a total number of bentonite sacks (total weight) was used to verify bentonite quantities. Field calculations used to determine and verify the amount of bentonite applied to the RGF material has been included in Appendix A.

Mixing of the bentonite with the RGF material was accomplished using a similar manner as was used for clod reduction, a pull-behind mixing rototiller. Upon completion of the mixing, moisture content was verified and adjusted if needed. The mixed material was then hauled to a post-mixing stockpile area.

2.2.3 Clay Liner Placement and Compaction

The RGF and bentonite mixed material from the post-mixing stockpile was placed on the prepared subgrade of the test pad. Subgrade preparation of the test pad was accomplished by overexcavating the subgrade 3 ft and filling back up to grade by placing material in 8-in. lifts and compacting with a smooth drum roller.

The mixed material was placed in 8-in. loose lift and compacted with either a CAT 815 sheepsfoot compactor or a CAT 825 sheepsfoot compactor for Lane A and Lane B, respectively. For study purposes, the first two lifts on both lanes were compacted with two passes, followed by moisture/density testing to determine the percent compaction. One pass was defined as the compactor traveling back and forth over a given area (two-way). After this initial testing, the compaction was resumed as scheduled according to information on Table 1.

Table 1. Compaction scheduling for Lanes A and B.

Lift No.	Lane A (CAT 815) (number of passes)	Lane B (CAT 825) (number of passes)
1	4	4
2	4	4
3	6	4
4	6	4
5	5	4
6	5	4
7	5	4
8	5	—[a]

a. Eighth lift not required for Lane B. See Section 4.5.

In order to prevent lamination, the existing compacted lift was scarified with a John Deere bulldozer and/or a CAT motor grader, and a light spray of water was applied prior placement of the new material.

3. PROJECT CQA DOCUMENTATION

Project documentation was prepared by CQA personnel as part of the CQA duties and consisted of a system of daily recordkeeping. This recordkeeping included daily progress reports and a record of various test data sheets pertinent to the test pad construction. Copies of the original records are being maintained in the ICDF office.

Copies of the daily progress reports summarizing the Contractor's progress and associated CQA activities prepared by the lead CQA monitor are presented in Appendix B of this report. A photographic log showing the pertinent part of the test pad construction is included in Appendix C.

Other CQA documentation with respect to test data and observation sheets is discussed within each phase of the following sections. Copies and summaries of various data for the field and laboratory testing are included in the applicable appendices of this report.

In order to verify that the test pad had been constructed in general conformance with the project specifications, as-built survey drawings have been prepared by the INEEL surveyor, showing the actual locations, elevations, and grades of the completed test pad. These drawings are included in Appendix D of this report.

4. TESTING RESULTS

To verify the material and construction method used for the construction of the test pad, laboratory testing, field testing, and field verification were performed throughout the construction in accordance with the test pad construction quality assurance plan. Each of these items and corresponding testing results are discussed in the following sections.

4.1 Material Certification

The bentonite manufacturer's QC certificates were reviewed by the CQA certifying officer. The manufacturer's quality control test results indicated that the bentonite met the technical specifications. Manufacturer's QC certificates have been included in Appendix A.

4.2 Classification Testing

Soil classification testing, which consists of Atterberg limits and particle size distribution (sieve analysis, hydrometer, and dispersive characteristics of clay soil of the mixed materials), was performed.

4.2.1 Atterberg Limits

As per the CQA requirements, four Atterberg limits tests were performed on the mixed materials. The Atterberg limits tests were performed in accordance with ASTM D 4318. The results of the Atterberg limits tests are summarized in Appendix A. The test results indicated that the mixed material had the following characteristics: liquid limits ranging from 34.7% to 39.2% and plasticity index ranging from 19.0% to 26.0%. The plasticity index shows all of the material is classified as a lean clay (CL).

4.2.2 Particle Size Distribution

As per the CQA requirements, four samples were collected for particle size analysis of soils and for dispersive characteristics of clay soil by double hydrometer. Both tests were performed in accordance with ASTM D 422 and ASTM D 4221, respectively. Results of these tests are also summarized in Appendix A. The test results indicated material passing the No. 200 wash sieve ranged from 88.9 to 90.1%. The double hydrometer results ranged from 20 to 29%. Only 15% of clays are dispersive with this range of double hydrometer results according to ASTM D 4221. Moreover, gravels provide good filters for clay soils based on studies performed by Sherard et al. (1985). The natural alluvial gravels underlying the soil bentonite liner will provide a filter preventing dispersion if the clay was dispersive. We propose no further testing since the underlying gravels will prevent migration of the clay particles in the unlikely event that the soil bentonite liner material was dispersive.

4.3 Natural Moisture Content

Natural moisture content tests were performed in accordance with ASTM D 2216 throughout the project. Since the moisture content test is done as part of other geotechnical tests, these moisture content values will be presented along with their respective test.

4.4 Moisture-Density Relationship (Proctor)

Moisture-density relationship tests (modified Proctor) were performed in accordance with ASTM D 1557. Results of the four Proctor tests are summarized in Appendix A. Test results of these samples indicated the appropriateness of using 113.2 pcf as the maximum dry density value and 15.3% as the optimum moisture content to be used as the controlling values for field moisture-density criteria. During Phase II construction, an average Proctor value will most likely be used.

4.5 Field In-place Moisture-Density

Field density and moisture content tests were performed throughout the test pad construction. Field density tests were performed in accordance with ASTM D 2922, and field moisture content tests were performed in accordance with ASTM D 3017. Both field tests were performed utilizing an electronic nuclear gauge. The holes in the clay liner resulting from the testing were filled with granular bentonite.

As required by CQA document, three moisture and density tests were performed per two passes for the first and second lift and three tests per lift for the remaining lifts. Due to a slight varying thickness during the placement, the required thickness of 3 ft for the test pad was placed in eight lifts for Lane A and in seven lifts in Lane B. Although the required minimum thickness was 3 ft, the test pad was constructed to 3.5 ft. These lifts resulted to 39 and 31 moisture-density tests for Lane A and Lane B, respectively. Based on the previous study, it was determined that the minimum criterion for moisture-density test is 92% compaction of maximum dry density at moisture content of optimum to +3% above optimum moisture content.

As shown on the summary of moisture and density test results presented in Appendix A, all material compacted by five or six passes for Lane A achieved the project criteria. Material compacted by four passes or less in Lane A was not consistently able to achieve the 92% compaction criteria. Moisture-density test results of Lane B indicated that all material compacted in four passes met the required compaction criteria.

The moisture content results obtained by the nuclear gauge were closely monitored throughout the construction by comparing the moisture content results obtained by the oven-dried method (ASTM D 2216). The oven-dried samples were collected from the same location as the moisture-density tests. The data indicated that moisture content measurement by nuclear gauge has acceptable accuracy in determining the overall percent compaction.

Field density measurements were also performed utilizing the sand-cone method. Based on the sand cone and nuclear gauge results, the wet density determined by the nuclear gauge was within 2% of the wet density obtained by the sand cone method. Results of the density measurements by the sand cone are presented in Appendix A.

4.6 Laboratory Permeability

Permeability (hydraulic conductivity) testing was performed to determine the permeability of the clay liner in a relatively undisturbed state (see Table 2). Core samples for flexible wall, falling head/rising tail water permeability tests were obtained at the frequency described in the CQA document (three samples for each Boutwell field permeability test and one for each repair location, for a total of 38 samples). The drive tube samples were obtained by pushing a thin-walled metal tube into the clay at the same elevation adjacent to the Boutwell permeameter test locations. The tubes were pushed into the clay with a flat metal plate pushed by a hydraulic energy pack, and each sample was removed by manually digging the sample out. Permeability tests were performed in Vector's geotechnical laboratory in Grass Valley, California. Tests were performed according to the procedures outlined in ASTM D 5084.

Table 2. Hydraulic conductivity summary report.

ector Engineering Inc.

12438 Loma Rica, Grass Valley, CA, 530-272-2448

LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY

SUMMARY REPORT

ASTM D - 5084

Client: Northwind Environmental | Project No: 011211.00 | Lab Log: 616

Project Name: INTAC/ CDF Test Pad | Report Date: November 12, 2001

Sample Identification:	Lane A TPCL #39R	Lane B TPCL # 31R	1A1 NE	1A2 NW	1A3 SE	2A1 NE
Lab Sample Number:	616A	616B	616C	616D	616E	616F
INITIAL:						
Water Content (%):	19.6	20.9	16.2	14.7	19.9	19.3
Dry Density (pcf):	106	103	111	110	96	97
Saturation (%):	90	88	85	74	72	70
FINAL:						
Water Content (%):	20.7	21.6	19.2	19.4	28.0	25.7
Dry Density (pcf):	106	105	110	108	95	98
Saturation (%):	95	95	98	95	98	96
Hydraulic Conductivity (cm / sec):	**1.4E-08**	**1.2E-08**	**1.3E-08**	**5.2E-08**	**3.8E-08**	**2.3E-07**
Effective Consolidation Pressure (psi):	5	5	5	5	5	5
Gradient Range:						
Relative Compaction (%):						
Notes:						

Sample Identification:	2A2 NW (TOP)	2A2 NW (BOTTOM)	2A3 SW (TOP)	2A3 SW (BOTTOM)	3A1 NE	3A2 NW
Lab Sample Number:	616G	616G1	616H	616H1	616I	616J
INITIAL:						
Water Content (%):	22.6	17.1	17.4	16.9	15.2	14.5
Dry Density (pcf):	93	100	93	102	110	112
Saturation (%):	74	67	58	70	78	78
FINAL:						
Water Content (%):	27.9	22.3	27.1	22.6	19.5	19.0
Dry Density (pcf):	94	103	96	104	109	110
Saturation (%):	95	94	96	97	97	97
Hydraulic Conductivity (cm / sec):	**9.3E-07**	**2.5E-07**	**4.8E-06**	**1.4E-07**	**7.7E-09**	**2.3E-08**
Effective Consolidation Pressure (psi):	5	5	5	5	5	5
Gradient Range:						
Relative Compaction (%):						
Notes:						

NOTES:
De-aired tap water was used as permeant.
The above Saturation is based upon an assumed Specific Gravity of 2.70.

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Table 2. (continued).

ector Engineering Inc.

12438 Loma Rica, Grass Valley, CA, 530-272-2448

LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY

SUMMARY REPORT

ASTM D - 5084

Client: Northwind Environmental
Project No: 011211.00
Lab Log: 616
Project Name: INTAC/ CDF Test Pad
Report Date: November 12, 2001

Sample Identification:	3A3 SW	4A1 NE	4A2 NW	4A3 SE	5A1 NE	5A2 NW
Lab Sample Number:	616K	616L	616M	616N	616O	616P
INITIAL:						
Water Content (%):	15.3	14.8	14.9	15.1	15.6	16.5
Dry Density (pcf):	106	111	109	107	111	110
Saturation (%):	71	78	73	71	81	84
FINAL:						
Water Content (%):	21.1	18.8	20.0	20.4	19.3	19.6
Dry Density (pcf):	105	112	108	107	109	110
Saturation (%):	93	100	96	95	96	99
Hydraulic Conductivity (cm / sec):	**6.2E-08**	**1.1E-08**	**4.0E-08**	**2.5E-08**	**3.0E-08**	**1.7E-08**
Effective Consolidation Pressure (psi):	5	5	5	5	5	5
Gradient Range:						
Relative Compaction (%):						
Notes:						

Sample Identification:	5A3 SE	6A1 NE	6A2 NW	6A3 SE	1B1 NE	1B2 SE
Lab Sample Number:	616Q	616R	616S	616T	616U	616V
INITIAL:						
Water Content (%):	14.8	17.0	14.7	15.2	17.3	17.4
Dry Density (pcf):	112	99	95	107	101	105
Saturation (%):	78	65	51	71	69	78
FINAL:						
Water Content (%):	19.3	24.2	24.0	20.4	23.6	21.5
Dry Density (pcf):	110	100	96	106	101	105
Saturation (%):	97	96	86	95	95	96
Hydraulic Conductivity (cm / sec):	**8.2E-09**	**4.2E-07**	**1.1E-07**	**1.0E-08**	**1.1E-07**	**3.0E-08**
Effective Consolidation Pressure (psi):	5	5	5	5	5	5
Gradient Range:						
Relative Compaction (%):						
Notes:						

NOTES:
De-aired tap water was used as permeant.
The above Saturation is based upon an assumed Specific Gravity of 2.70.

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Lab Log: 616
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Table 2. (continued).

ector Engineering Inc.

12438 Loma Rica, Grass Valley, CA, 530-272-2448

LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY

SUMMARY REPORT

ASTM D - 5084

Client: Northwind Environmental — Project No: 011211.00 — Lab Log: **616**

Project Name: INTAC/ CDF Test Pad — Report Date: November 12, 2001

Sample Identification:	1B3 SW	2B1 NE	2B2 NW	2B3 SW	3B1 NE	3B2 NW
Lab Sample Number:	616W	616X	616Y	616Z	616AA	616AB
INITIAL:						
Water Content (%):	16.4	16.3	18.1	16.7	16.8	16.7
Dry Density (pcf):	98	107	94	96	109	110
Saturation (%):	61	77	61	60	83	85
FINAL:						
Water Content (%):	23.3	21.0	26.1	26.4	19.8	19.0
Dry Density (pcf):	100	105	98	96	108	110
Saturation (%):	93	95	97	95	96	95
Hydraulic Conductivity (cm / sec):	**1.4E-07**	**2.7E-08**	**4.7E-08**	**2.5E-08**	**5.8E-09**	**3.0E-09**
Effective Consolidation Pressure (psi):	5	5	5	5	5	5
Gradient Range:						
Relative Compaction (%):						
Notes:						

Sample Identification:	3B3 SE	4B1 NE	4B2 SE	4B3 SW	5B1 NE	5B2 NW
Lab Sample Number:	616AC	616AD	616AE	616AF	616AG	616AH
INITIAL:						
Water Content (%):	17.0	16.8	16.3	16.5	16.5	17.2
Dry Density (pcf):	110	110	113	112	112	111
Saturation (%):	86	85	88	87	88	90
FINAL:						
Water Content (%):	19.7	20.0	19.1	19.1	19.3	19.4
Dry Density (pcf):	109	109	110	110	109	109
Saturation (%):	98	98	97	97	96	97
Hydraulic Conductivity (cm / sec):	**3.5E-09**	**1.2E-08**	**1.0E-08**	**7.2E-09**	**1.2E-08**	**5.2E-09**
Effective Consolidation Pressure (psi):	5	5	5	5	5	5
Gradient Range:						
Relative Compaction (%):						
Notes:						

NOTES:
De-aired tap water was used as permeant.
The above Saturation is based upon an assumed Specific Gravity of 2.70.

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Table 2. (continued).

Vector Engineering Inc.

12438 Loma Rica. Grass Valley, CA. 530-272-2448

LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY

SUMMARY REPORT

ASTM D - 5084

Client: Northwind Environmental	Project No: 011211.00	Lab Log: 616
Project Name: INTAC/ CDF Test Pad	Report Date: November 12, 2001	

Sample Identification:	5B3 SW	6B1 NE	6B2 NW	6B3 SE		
Lab Sample Number:	616AI	616AJ	616AK	616AL		
INITIAL:						
Water Content (%):	16.9	18.5	18.8	16.9		
Dry Density (pcf):	110	99	104	106		
Saturation (%):	85	72	82	78		
FINAL:						
Water Content (%):	20.2	25.6	22.3	21.5		
Dry Density (pcf):	107	98	104	105		
Saturation (%):	95	96	97	95		
Hydraulic Conductivity (cm / sec):	**6.4E-09**	**9.5E-07**	**3.1E-07**	**4.1E-08**		
Effective Consolidation Pressure (psi):	5	5	5	5		
Gradient Range:						
Relative Compaction (%):						
Notes:						

Sample Identification:						
Lab Sample Number:						
INITIAL:						
Water Content (%):						
Dry Density (pcf):						
Saturation (%):						
FINAL:						
Water Content (%):						
Dry Density (pcf):						
Saturation (%):						
Hydraulic Conductivity (cm / sec):						
Effective Consolidation Pressure (psi):						
Gradient Range:						
Relative Compaction (%):						
Notes:						

NOTES:
De-aired tap water was used as permeant.
The above Saturation is based upon an assumed Specific Gravity of 2.70.

These results apply only to the above listed samples.
By accepting the data and results on this page, client agrees to limit the liability of Vector Engineering, Inc. from Client and all other parties' claims arising out of the use of this data to the cost for the respective test(s) represented here, and Client agrees to indemnify and hold harmless Vector from and against all liability in excess of the aforementioned limit.

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The laboratory permeability test results ranged from 4.8×10^{-6} cm/sec to 3.0×10^{-9} cm/sec. The results of the laboratory permeability testing are tabulated in Appendix A. Permeability tests were performed at an effective stress of 5 pounds per square inch (psi). Saturation was confirmed once the change in the height of water in the inlet buret equaled the change in the height of water in the outlet buret and a "B" parameter was obtained. The "B" values were within the acceptable ranges identified in ASTM D 5084. Discussion and conclusions based on the laboratory permeability tests are given in detail in Section 5.0, Summary and Conclusions.

4.7 Field Permeability – Boutwell Permeameter

Field permeability tests using Boutwell permeameter (one stage) were performed in general accordance to ASTM D 6391. The one stage test is performed to determine the maximum effect of vertical permeability (k_v). In general, this test is performed by installing a section of 6-in.-diameter casing in a predrilled hole and sealing the annular space between the casing and the borehole with grout. The flow control systems and a standpipe to the casing are attached to the installed section of the casing. The casing, flow control system, and standpipe were then filled with water. The quantity of water migrating into the soil liner and the corresponding time it took were recorded until a steady-state flow condition was achieved. Once the steady state condition was achieved, the test was concluded and the data were summarized.

The field permeability tests were performed at the frequency described in CQA document (six tests per test pad for a total of 12 tests). The field permeability test results ranged from 1.3×10^{-6} cm/sec to 2.3×10^{-8} cm/sec. The results of the field permeability testing are tabulated in Appendix A. Discussion and conclusions based on the field permeability tests are given in detail in Section 5.0, Summary and Conclusions.

5. SUMMARY AND CONCLUSIONS

5.1 Construction Method

Based on test results and observations during the test pad construction, the following recommendations and conclusions regarding the construction methods, equipment, techniques, and materials are presented below.

- The permeability test results indicate that the placement of the material in maximum 8-in. loose lifts and compacted with a minimum of four passes with the CAT 825 sheepsfoot compactor will achieve a clay liner permeability that meets the minimum specifications.

- The use of the CAT 825 sheepsfoot compactor over the CAT 815 sheepsfoot compactor is recommended for compacting the clay liner. The test pad constructed with the CAT 825 compactor resulted in lower permeabilities than those with the CAT 815. In addition, fewer number of passes were required with the CAT 825 than with the CAT 815 to achieve the desired results.

- The method of spreading the dry bentonite should be reevaluated prior to Phase II construction. The method used did not adequately distribute the desired quantity of bentonite evenly over the mixing area. A consistent method that allows the operator to document and control the amount of bentonite being placed is preferred. Recommended is the use of a lime spreader truck or equivalent, equipped with a scale or other measuring device which will allow the operator to dispense the bentonite accurately and to better control the placement. The use of the lime spreader truck and rotatiller type mixer is being evaluated by the Contractor and will most likely be implemented for Phase II construction.

- A change is being evaluated to use a bentonite product with significantly less fines passing the No. 200 sieve to reduce the impact of wind. Envirogel 200 which was used on the test pad has 80% passing the No. 200 sieve. Envirogel 10 is being evaluated for use during Phase II construction. Envirogel 10 only has 20% passing the No. 200 sieve.

- At the completion of the test pad and during the excavation of the test, no slip planes between the lifts or obvious faulty areas were observed. However, drying and desiccation cracking were observed in the top surface to a depth of 4 in. It is recommended that, during construction, the geomembrane liner be placed immediately over the completed clay liner surface. Constructing the clay liner 4 to 6 in. thicker and then cutting the material to final grade shortly before liner installation is highly recommended. If the clay liner is exposed for any length of time, continuous maintenance (watering and smooth drum rolling) will be required.

5.2 Clay Material Testing

Based on the test results, the following are Vector's conclusions and/or recommendation for the clay material:

- The permeability test results based on the laboratory testing for the clay liner material indicate that, if the material is compacted and moisture-conditioned to the specified dry densities and moisture content, the permeability of 1×10^{-7} cm/sec can be achieved.

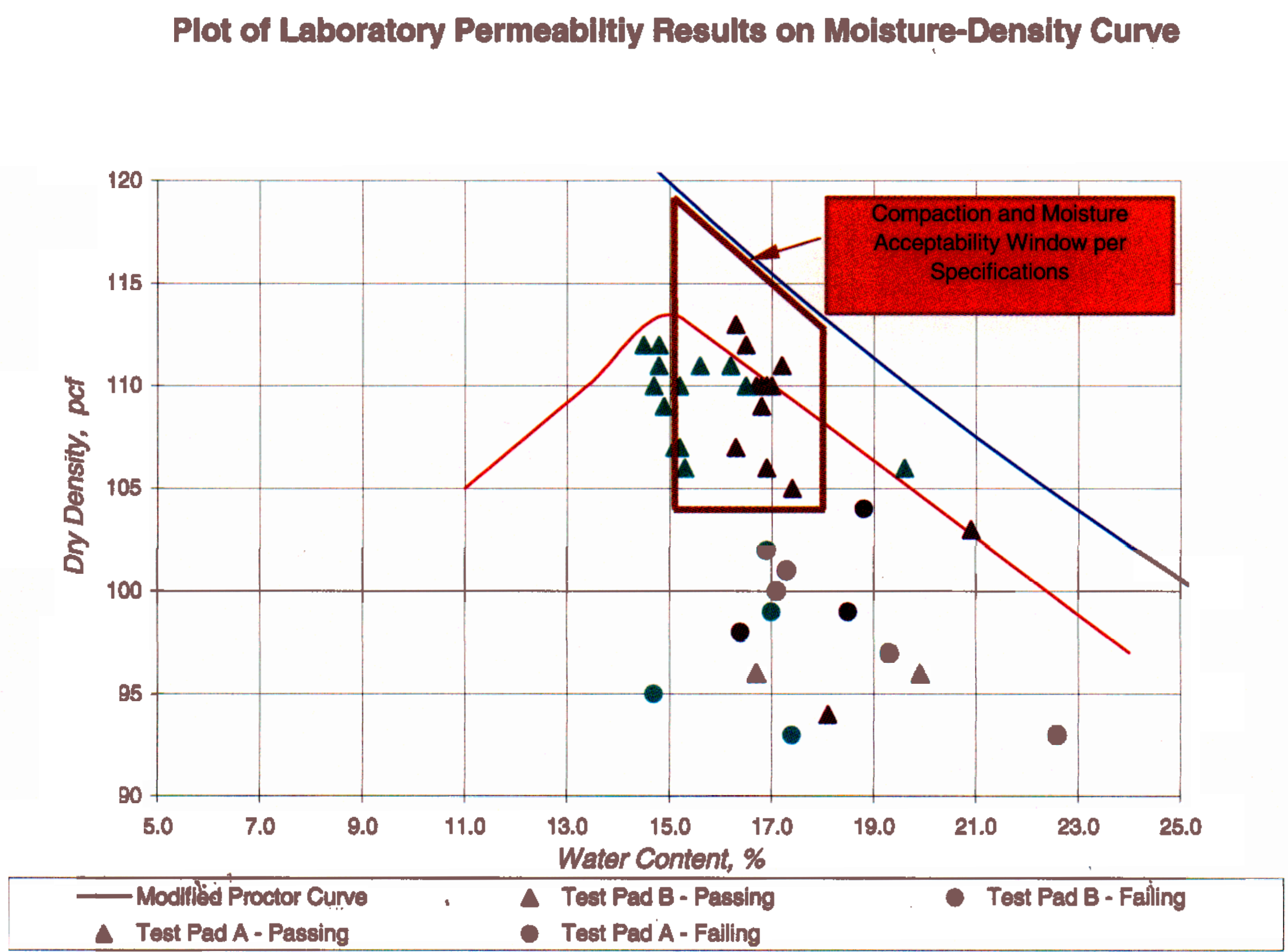
- As shown in the laboratory test results, six samples failed to meet the specified permeability. However, the dry density for these samples was lower than the specified 92% compaction, thus giving a reasonable explanation for the failing tests. Four field permeability tests also failed to meet the specified permeability. These failures occurred in the tests taken at minus 1 ft below grade. Because these failures were on the higher elevation tests and desiccation cracking was observed, it may be concluded that one reason for the higher permeability in these tests is the drying out of the surface of the test pad. Another issue that may be attributed to these tests is an insufficient seal between the casing and the borehole, thus creating a "channel" effect.

- By comparing the field permeabilities with the average laboratory permeabilities performed at each given field test location and by eliminating the two outlayers, a correlation between the field permeability and the laboratory permeability was developed. The average field permeability is approximately 5.2 times faster than the laboratory permeability. In addition a correlation was developed for Lane "B" only. Based on this correlation, in order to achieve a minimum permeability in the field of 1×10^{-7} cm/sec, the laboratory permeability should be a minimum of 5×10^{-8} cm/sec.

- The laboratory permeabilities were plotted on a moisture-density relationship curve, as shown in Figure 1. In addition, a window showing the acceptable dry density and moisture conditions (minimum 92% compaction at a moisture content of optimum to +3% of optimum) specified in the technical specifications was plotted in Figure 1. As the plot indicates, the passing permeability tests (less than 1×10^{-7} cm/sec) are within the specified window and the failing tests fall outside the window.

5.3 Construction of Test Pad for Phase II

Prior to the construction of Phase II, an additional test pad will be constructed on the 3:1 slope. For the construction of this test pad, use of the CAT 825 compactor is recommended. As discussed in Section 5.1, a different method for the application of the dry bentonite is recommended to be proposed and implemented. Given the amount of field permeabilities completed for the Phase I test pad, a correlation has been developed between the field permeability and the laboratory permeability, and additional Boutwell tests are not recommended to be required.



Passing Test is results less than 1 x 10-7 cm/sec Failing Test is results greater than 1 x 10-7 cm/sec

Figure 1. Plot of laboratory permeability results on moisture-density curve.

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